

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
25 January 2001 (25.01.2001)

PCT

(10) International Publication Number  
**WO 01/06311 A1**

(51) International Patent Classification<sup>7</sup>: **G02F 1/1347, 1/1335**

(74) Agent: BAELE, Ingrid, A., F., M.; Internationaal Ocroibureau B.V., Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(21) International Application Number: **PCT/EP00/06683**

(81) Designated States (national): CN, JP.

(22) International Filing Date: **13 July 2000 (13.07.2000)**

(84) Designated States (regional): European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

(25) Filing Language: **English**

Published:

- *With international search report.*
- *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*

(26) Publication Language: **English**

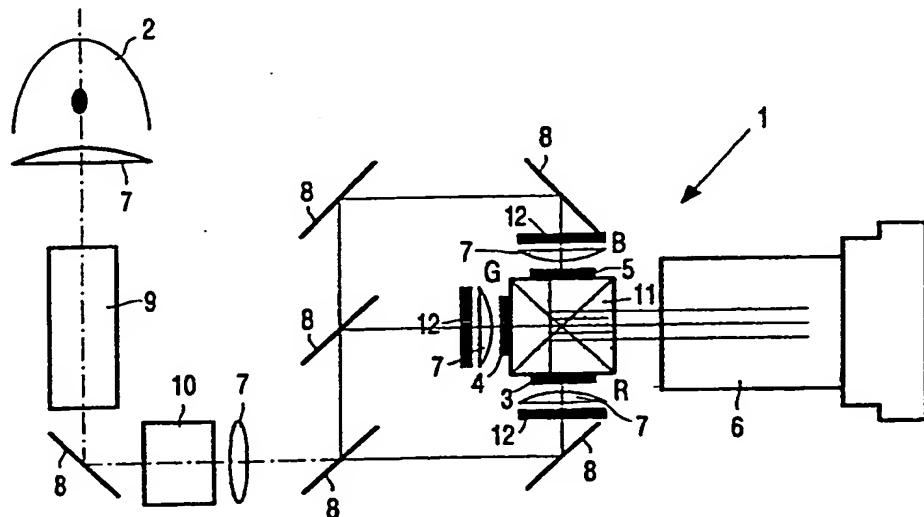
*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(30) Priority Data:  
**99202384.6 20 July 1999 (20.07.1999) EP**

(71) Applicant: **KONINKLIJKE PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).**

(72) Inventors: **DE VAAN, Adrianus, J., S., M.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). VAN LERBERGHE, Steven, J., W.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).**

(54) Title: **METHOD AND DEVICE FOR WHITE BALANCE ADJUSTMENT**



**WO 01/06311 A1**

(57) Abstract: Method of adjusting a desired white color on at least a part of an image by means of a device comprising at least a light source (2) and at least an electro-optical light modulation panel (3, 4, 5). The light coming from the light source is converted into an image via at least the electro-optical light modulation panel. A light control device (12) co-operating with a light modulation panel is associated with this panel. For adjusting the desired white color, the electro-optical light modulation panel is driven through at least a part to a desired maximum voltage. The part is imaged on the part of the image. The color of the part of the image is adapted to the desired white color by means of the light control device.

## METHOD AND DEVICE FOR WHITE BALANCE ADJUSTMENT

The invention relates to a method of adjusting a desired white color on at least a part of an image by means of a device comprising at least a light source and at least an electro-optical light modulation panel, in which method the light from the light source is converted into an image via at least the electro-optical light modulation panel.

5 The invention also relates to a device which is suitable for generating at least an image, at least a part of which has a desired white color, which device comprises at least a light source and at least an electro-optical light modulation panel.

10 In such a known device, for example three different light modulation panels generate red, green and blue-colored parts of the image which are subsequently imaged as a single image on a projection plane by means of a projection lens situated on a side remote from the light source.

15 It is alternatively possible to generate parts of an image associated with three different colors consecutively in complete parts or scrolling parts by means of only a single light modulation panel.

20 Optical elements such as dichroic deflection mirrors, lenses, prisms etc. whose optical transmission will be slightly different for each color, are situated between the light source and the light modulation panels as well as between the light modulation panels and the projection lens. Moreover, similar devices may be slightly different due to small mechanical and/or optical deviations. Consequently, the primary colors red, green and blue and the white color will be different for each device. If the light modulation panels are, for example, LCDs, a desired white color can still be obtained by driving the LCDs in different ways. For one or two LCDs, the maximum allowable drive voltage is decreased. Due to the physical properties, inter alia the transmission drive curve, of the LCD, this will be at the expense of the maximum contrast to be realized with the LCD. As a result, the maximum contrast to be achieved for each LCD will also differ so that color errors may occur. At different maximal drive voltages of the three LCDs, the LCDs have different, non-linear drive curves so that it becomes relatively complicated to drive the three LCDs.

The same drive problem occurs if the device has only one line modulation panel.

If, moreover, the projection plane itself is not white, the human eye will observe the actual color of the projection plane instead of a white color, even when the 5 device is adjusted correctly.

It is an object of the invention to provide a method and a device in which a 10 desired white color can be realized in a simple manner while avoiding the above-mentioned drawbacks.

In the method according to the invention, this object is achieved in that a light control device co-operating with the light modulation panel is associated with said panel, in which, for adjusting the desired white color, the electro-optical light modulation panel is driven through at least a part to a desired maximum, which part is imaged on the part of the 15 image, whereafter the color of the part of the image is adapted to the desired white color by means of the light control device.

By driving the light modulation panel to a desired maximum, it is possible to 20 operate the light modulation panel in accordance with the same drive curve for each color, while the same maximum contrast can be realized for each color. As a result, the drive of the light modulation panel is relatively simple. To achieve the desired white color, the light 25 control device is adjusted manually or automatically per color.

An embodiment of the method according to the invention is characterized in that the device comprises at least three electro-optical light modulation panels, in which a light control device co-operating with each light modulation panel is associated with said 25 panel, in which, for adjusting the desired white color, the electro-optical light modulation panels are each driven through at least the same part to a desired maximum, which parts are imaged on the part of the image, whereafter the color of the part of the image is adapted to the desired white color by means of the light control devices.

In this way, it is possible to operate each light modulation panel in accordance 30 with the same drive curve, while the same maximum contrast can be realized with each light modulation panel. Consequently, the drive of the light modulation panels is relatively simple.

Another embodiment of the method according to the invention is characterized in that the color of the part of the image is detected by means of a sensor, in that subsequently the detected color is compared by a control means with a desired white color, and, if the

detected color does not correspond to the desired white color, the light control device(s) is (are) subsequently driven by the control means until the desired color corresponds to the desired white color.

5 It is even possible to realize an image with a desired white part even on a projection plane having, for example, a pastel-like color by the control means and the sensor connected thereto.

In the device according to the invention, the object is achieved in that a light control device co-operating with a light modulation panel is associated with said panel, which light control device is adjustable when driving the light modulation panel to the desired 10 maximum, so that the part of the image has the desired white color.

The maximum drive voltage may be equal for each color so that the linearity of the drive and the contrast for each color is optimal.

15 These and other aspects are apparent from and will be elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 shows a first embodiment of a device 1 according to the invention,

Fig. 2 shows a second embodiment of a device according to the invention,

20 Fig. 3 shows diagrammatically a third embodiment of a device according to the invention.

In the Figures, corresponding components are denoted by the same reference 25 numerals.

Fig. 1 shows a device 1 according to the invention, comprising a light source 2, three electro-optical light modulation panels 3, 4, 5 with which a red R, a green G and a blue B part of an image to be imaged are realized, and a projection lens 6. The device 1 further comprises, between the light source 2 and the light modulation panels 3-5, lenses 7, (dichroic) deflection mirrors 8, PCS 9 and integrator 10. The lenses 7, (dichroic) deflection 30 mirrors 8, PCS 9 and integrator 10 are known per se and will not be further described. The device 1 is further provided with a dichroic prism 11 situated between the light modulation panels 3-5 and the projection lens 6. The device 1 is also provided with three light control

devices 12 which are situated on a side of the light modulation panels 3-5 remote from the prism 11.

Each light control device 12 is provided with an LCD element which comprises only a single electrode (single pixel). It is of course alternatively possible to use 5 the same LCD as for the light modulation panels 3-5.

The device 1 is adjusted to a desired white color as follows. The light emitted by the light source 2 is imaged on the light modulation panels 3-5 via the optical elements 7-10. Each light modulation panel is driven by the same desired maximum permissible voltage, whereafter the LCDs 3-5 are imaged on a projection plane (not shown) via prism 11 and the 10 projection lens 6. If the projected image has a desired white color, it is not necessary to take any further action. In most cases, the color on the projection plane will deviate from a desired white color due to the imperfections of the optical elements mentioned in the opening paragraph and the possible color of the projection plane itself. If the color of the projected image does not correspond to the desired white color, the light control devices 12 are driven, 15 at which the color of the projected image will change. The drive of the separate light control devices is changed until the color of the projected image corresponds to the desired white color. Subsequently, arbitrary images, white parts of which have a desired white color, can be generated by only driving the light modulation panels 3-5. The control devices 12 need not be readjusted until another adjustment is desired, for example, due to a change of the color of 20 the projection plane.

Fig. 2 shows a second embodiment of a device 20 according to the invention, comprising a light source 2, reflective light modulation panels 3-5 and a light source 12. The device 20 is further provided with lenses 7, (dichroic) deflection mirrors 8, PCS 9, integrator 10 and elements 21 arranged between the light source 2 and the light modulation panels 3-5. 25 The elements 21 and the dichroic prism 11 are situated between the light modulation panels 3-5 and the projection lens 6. The device 20 is further provided with a liquid crystal shutter 22 for three different colors, arranged on a side of the projection lens 6 remote from the light modulation panels 3-5. The liquid crystal shutter 22 is a special LCD element which comprises a stack of single-pixel LCD cells with color polarization filters in between. By 30 adapting the voltages of each cell in the stack, the extent of absorption for red, green and blue can be adjusted when the light modulation panels 3-5 are driven to a desired maximum.

Fig. 3 shows diagrammatically a third embodiment of a device 30 according to the invention, comprising a device 1, shown in Fig. 1, or a device 20, shown in Fig. 2, a projection plane 31, a sensor 32 and a control means 33. The light-control devices 12 and 22

of the devices 1 and 20, respectively, and the light modulation panels 3-5 are driven by the control means 33. The image generated by the device 1, 20 is imaged on the projection plane 31. The projected image is detected by means of a sensor 32 and subsequently analyzed in the control means 33. If the device 1 and 20 are driven by the control means 33 in such a way 5 that an image with a white part is to be imaged on the projection plane 31, the color detected by the sensor will be compared with the desired white color. If the two colors do not correspond, the drives of the light control devices 12 and 22 are changed by the control means 33 until the color detected by the sensor 32 corresponds to the desired white color. This color, which is present on the projection plane 31, will also be observed as white by the 10 human eye 34.

The device according to the invention is applicable in projection systems, computer monitors, etc.

It is alternatively possible to use DMDs or other light devices as light modulation panels instead of LCDs.

15 It is alternatively possible to use only a single light modulation panel, in which the red, blue and green color parts of the images are consecutively generated by means of the light modulation panel. The light modulation panel may be driven in such a way that, at a specific instant, the light modulation panel generates the part associated with red, green or blue or drives this part in such a way that the parts associated with the three colors are 20 generated in a scrolling manner across the light modulation panel. Elements should then be arranged in front of or behind the light modulation panel, so that the part associated with the relevant color is imaged in this color.

## CLAIMS:

1. A method of adjusting a desired white color on at least a part of an image by means of a device comprising at least a light source and at least an electro-optical light modulation panel, in which method the light from the light source is converted into an image via at least the electro-optical light modulation panel, characterized in that a light-control device co-operating with the light modulation panel is associated with said panel, in which, for adjusting the desired white color, the electro-optical light modulation panel is driven through at least a part to a desired maximum, which part is imaged on the part of the image, whereafter the color of the part of the image is adapted to the desired white color by means of the light control device.  
10
2. A method as claimed in claim 1, characterized in that the device comprises at least three electro-optical light modulation panels, in which a light control device co-operating with each light modulation panel is associated with said panel, in which, for adjusting the desired white color, the electro-optical light modulation panels are each driven through at least the same part to a desired maximum, which parts are imaged on the part of the image, whereafter the color of the part of the image is adapted to the desired white color by means of the light control devices.  
15
3. A method as claimed in claim 1, characterized in that parts of the image to be imaged associated with three different colors are consecutively generated by means of the light modulation panel, whereafter the color of the part of the image is adapted to the desired white color by means of the light control device.  
20
4. A method as claimed in any one of the preceding claims, characterized in that the color of the part of the image is detected by means of a sensor, in that subsequently the detected color is compared by a control means with a desired white color, and, if the detected color does not correspond to the desired white color, the light control device(s) is (are) subsequently driven by the control means until the desired color corresponds to the desired white color.  
25

5. A device suitable for generating at least an image, at least a part of which has a desired white color, which device comprises at least a light source and at least an electro-optical light modulation panel, characterized in that a light control device co-operating with the light modulation panel is associated with said panel, said light control device being

5 adjustable when driving the light modulation panel to the desired maximum, so that the part of the image has the desired white color.

6. A device as claimed in claim 5, characterized in that the device comprises at least three electro-optical light modulation panels and light control devices co-operating

10 therewith, said light control devices being adjustable when driving the light modulation panels to the desired maxima, so that the part of the image has the desired white color.

7. A device as claimed in claim 5, characterized in that the light modulation panel can be consecutively driven for parts, associated with three different colors, of the

15 image to be imaged.

8. A device as claimed in any one of the preceding claims 5-7, characterized in that the device is provided with a control means for driving the light control device(s), and a sensor, coupled to the control means, for detecting the real color of the part.

20

9. A device as claimed in any one of claims 5-8, characterized in that the light control device comprises an LCD which is provided with a single electrode.

10. A device as claimed in any one of claims 5-8, characterized in that three light

25 control devices are arranged in a single LCD element, which LCD element is provided with at least three stacked LCD cells each comprising a single electrode between which color polarization filters are situated.

1/1

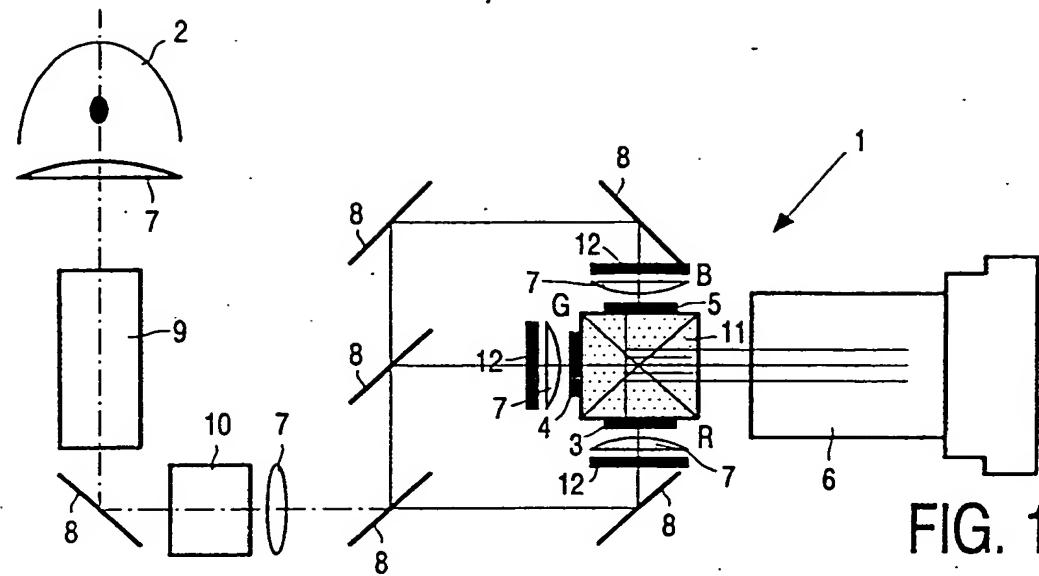


FIG. 1

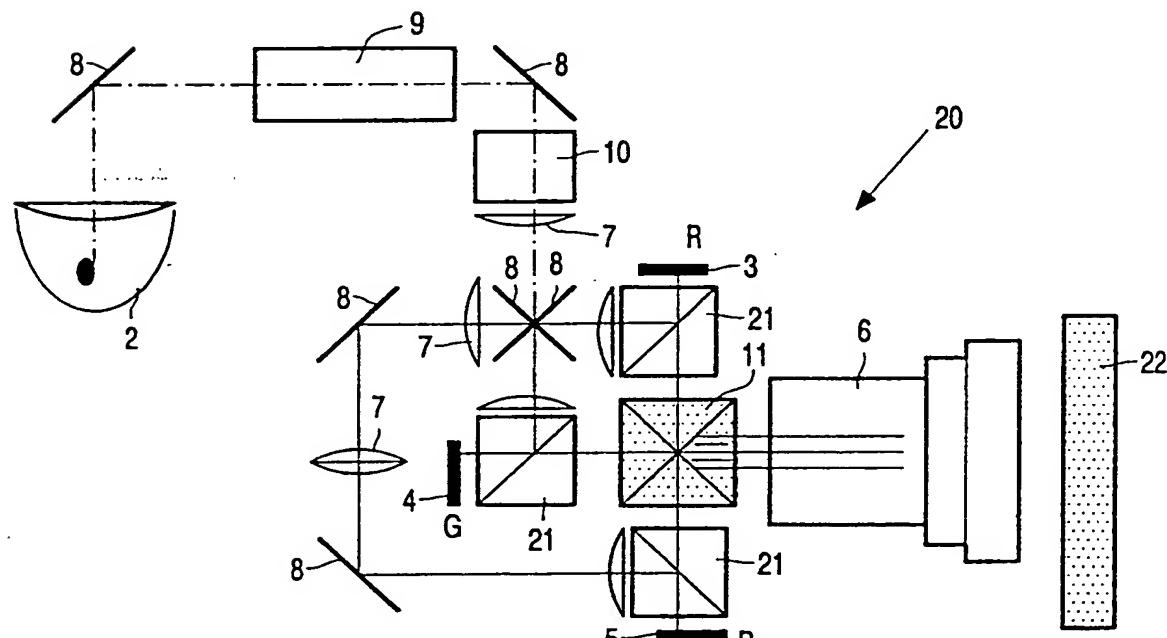


FIG. 2

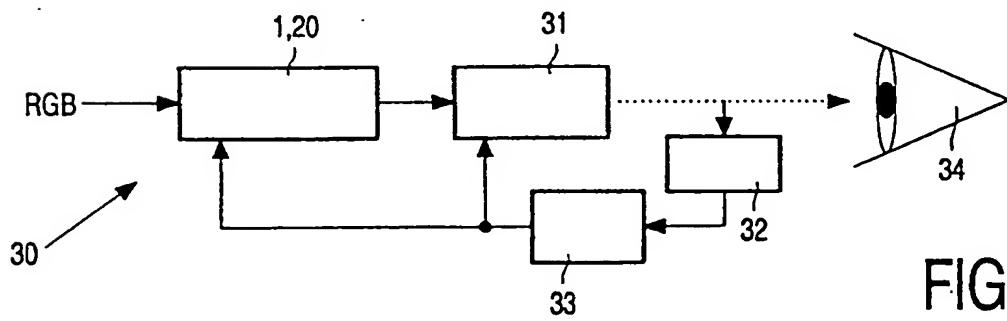


FIG. 3

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 00/06683

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 G02F1/1347 G02F1/1335

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 G02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 087 176 A (NIGG JURG) 2 May 1978 (1978-05-02) column 1, line 23 - line 30 column 1, line 56 - line 64 column 6, line 9 - line 11 figure 1	1-9
Y	US 5 539 547 A (ISHII YUTAKA ET AL) 23 July 1996 (1996-07-23) column 14, line 39 - line 42 column 16, line 44 - line 47 figures 6,11	10
Y		10

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

### \* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*&\* document member of the same patent family

Date of the actual completion of the international search

1 December 2000

Date of mailing of the international search report

13/12/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patenttaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl.  
Fax (+31-70) 340-3016

Authorized officer

Petitpierre, O

# INTERNATIONAL SEARCH REPORT

Int'l. Jonal Application No

PCT/EP 00/06683

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US 4087176	A 02-05-1978	CH	566016 A	29-08-1975
		DE	2360691 A	20-06-1974
		FR	2211132 A	12-07-1974
		GB	1459206 A	22-12-1976
		IT	1001048 B	20-04-1976
		JP	54091250 A	19-07-1979
		JP	49091226 A	31-08-1974
		US	4230408 A	28-10-1980
US 5539547	A 23-07-1996	JP	2818335 B	30-10-1998
		JP	5323295 A	07-12-1993
		DE	69323113 D	04-03-1999
		DE	69323113 T	22-07-1999
		EP	0571222 A	24-11-1993
		KR	130882 B	22-04-1998